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AMERICAN MECHANISM.

Modern Mechanism. Edited by Park Benjamin, LL.B., Ph.D. (London and New York: Macmillan and Co., 1892.)

IN order to appreciate this volume thoroughly, it is necessary in the first instance to consider the reason for its existence. Appleton's "Dictionary of Engineering," an American book, was published in the year 1851, and was the first to gather in cyclopedic form descriptions of products of American mechanical industry. Some thirty years afterwards it became necessary to bring the work up to date, and its complete reconstruction was decided upon. The editor observes that no previous work of a technical character had so signally, and so quickly, demonstrated its own usefulness; it rapidly became a recognized standard of American mechanical practice. Owing, however, to the great progress made in mechanical invention, and the marvellous rapidity with which electrical science has advanced, a new record of the results has become necessary, and hence the present volume.

The list of contributors includes the names of eminent men, well known in this country for their high attainments in the different branches of mechanical and electrical engineering, forming a sure guarantee that the information to be gleaned from the pages is valuable and accurate. It would be impossible in the space at our disposal to notice more than a small part of the contents. Some interesting information is to be found on the subject of aerial navigation, more particularly the interesting experiments being carried out by Mr. Hiram S. Maxim. Commenting on Prof. Langley's statement, that with a flying machine the greater the speed the less would be the power required, Mr. Maxim says: "In navigating the air we may reason as follows: if we make no allowance for skin friction and the resistance of the wires and framework passing through the air—these factors being very small indeed at moderate speeds as compared to the resistance offered by the aëroplane—we may assume that with a plane set at an angle of 1 in 10, and with the whole apparatus weighing 4000 pounds, the push of the screw would have to be 400 pounds. Suppose, now, that the speed should be 30 miles an hour; the energy required from the engine in useful effect on the machine would be 32 horse-power (30 miles = 2640 feet per minute, $\frac{2640 \times 400}{33,000} = 32$). Adding 20 per cent. for slip of screw, it would be 38·4 horse-power. Suppose, now, that we should increase the speed of the machine to 60 miles an hour, we could reduce the angle of the plane to 1 in 40, instead of 1 in 10, because the lifting power of a plane has been found to increase in proportion to the square of its velocity. A plane travelling through the air at the rate of 60 miles an hour, placed at an angle of 1 in 40, will lift the same as when placed at 1 in 10, and travelling at half this speed. The push of the screw would therefore have to be only 100 pounds, and it would require 16 horse-power in useful effect to drive the plane. Adding 10 per cent. for the slip of the screw, instead of 20, as for the lower speed, would increase the engine power required to 17·6 horse-power. These figures, of course, make no allowance for any loss by atmospheric friction. Suppose 10 per cent. to be consumed in atmospheric resistance when the complete machine was moving 30 miles an hour, it would then require 42·2 horse-power to drive it. Therefore at 30 miles an hour only 3·84 horse-power would be consumed by atmospheric friction, while with a speed of 60 miles an hour the engine power required to overcome this resistance would increase eightfold, or 30·7 horse-power, which, added to 17·6, would make 48·1 horse-power for 60 miles an hour."

Mr. Maxim goes on to observe that his experiments show that as much as 133 pounds can be carried with the expenditure of 1 horse-power, and under certain conditions as much as 250 pounds. It will be evident, therefore, that the question of motors is all important, and that the total weight per horse-power developed must be as low as possible. It is stated that the greatest force can be obtained from a compound high-pressure steam engine using steam at 200 to 350 pounds pressure, and such engines have been constructed weighing 300 pounds; the horse-power of these engines is not stated.

It will be interesting to watch the outcome of these investigations. They indicate that much information is being accumulated, and that sooner or later a successful aerial machine will be forthcoming.

The question of armour plates has long vexed the soul of the British Admiralty; many very costly trials have been carried out in order to find the most suitable plate for the service. All these data have probably been known in the States, and that country must have benefited by them. Under this heading we find much information in the book, American experiments being quoted and illustrated. Naturally, the Americans wish to make their own plates, and wisely endeavour to do so by rolling only, to do without the heavy expense of forging. These experiments show that the high-carbon nickel Harveyed plate is undoubtedly the best plate ever tested. As a result of these trials, orders have been placed for plates for the cruisers under construction. An excellent full-page engraving is given of the U.S. armoured battle ship *Indiana*, and to judge by the blackness of the smoke she is not using Welsh coal! The article on steam boilers is well written, and very complete, containing much useful information. Among the many types of boilers illustrated there is a good print of the Yarrow torpedo boat boiler. We miss, however, the familiar Thornycroft boiler, and note an American water tube-boiler for fast launches very like the Thornycroft in the arrangement of the tubes.

The boilers for marine purposes are purely of the British type, and there is nothing of importance to note on this subject beyond the many experimental results recorded.

Further on in the book there is an interesting description of railway-car heating. We are told that car-heating, in the usual acceptance of the term, has come to mean the heating of railway cars by the use of steam from the locomotive. This is important, showing as it does the direction in which American railway companies are moving in the solution of a problem at present occupying the best attention of engineers in this country. Generally, we are told, the systems consist of a separate hot-water circulating system in each car, in connection with a heater, fed by steam from the locomotive, by a continuous train pipe running the length of the train, and coupled together between the cars by flexible hose-pipes and universal couplings; the Sewall steam coupler being generally used. Another important railway necessity is the continuous brake. Under this heading the latest form of Westinghouse quick-action automatic brake is described. In the original design the brake is applied by the engine-driver allowing a little air to escape from the train pipe, lowering the pressure, and thus applying the brake by the automatic action of the triple valves. It is evident that the vehicle next the engine will feel this reduction first, and its triple valve will work before that on the second vehicle, and so on. On trains of ordinary length this very slight difference in time between the brake's application on each vehicle is of little consequence, but when this automatic brake is fitted to a long goods train it becomes a serious matter. The length of a goods train of fifty American cars is 1900 feet, and the brake should act instantaneously to be perfect. The new triple valve is itself designed to discharge air from the train pipe; so on the driver opening the driver's valve, allowing air to escape to apply the brakes, the reduction of pressure operates the triple valve on the first car; this lets out more air, and so on through the train, the brake on the last car, 1900 feet away, being operated in 2·5 seconds after that on the first car.

The vacuum automatic brake is not described or illustrated. This brake is now being more and more brought into use. and for general purposes it appears to be simpler and less liable to get out of order than its competitors.

A considerable part of the volume is taken up with the applications of electricity, for lighting and motive power purposes generally. On dynamo electric machinery much has been written and well illustrated. The reader is taken step by step from the rudiments of the subject to its latest applications, from a description of armatures to the arrangements of the field-magnets, then to the varying designs of dynamos, including most of the known machines. The same may be said on the treatment of the electric motors. Under the head of the transmission of power there is more useful information to be found, this being all the more interesting, because of the proposed use of electricity as a means of transmitting some of the power of Niagara to distant towns. There is, however, something wanting under the heading of electrical measuring instruments. The only ones mentioned are Weston's volt and ammeters. At the present time the street tramways of this country are in an uncertain stage as far as motive power is concerned; horse-power is admittedly expensive; the steam locomotive seems to have got into disrepute; the cable and electric traction appear to be struggling for the mastery. It is interesting therefore to read the memoir on electric traction in this volume. The accumulator system is just described, but the overhead cable or trolley system takes up the greater part of the space, so it is safe to assume that the latter is more generally in use, the principle of which is as follows: the current starts from the positive brush of the dynamo, passing out to the main conductor, suspended over the middle of the track, and along this conductor until it reaches the point where the trolley of one of the motor cars is in contact. Here it divides, and a portion passes down through the trolley to the motors, and thence to the rails forming a return lead to the negative brush of the generator. The main portion of the current passes on to feed other cars upon the line in the same manner, each car taking the quantity of current necessary to develop the required power. There are at the present time nearly 500 electric railways in America, and taking the results of twenty-two electric trolley lines, we find that the expenses vary per car mile from 22·99 cents to 7·89 cents, the highest and lowest respectively. A view is given of the electric street railway at Washington, D.C.; the overhead conductors being not at all unsightly.

On electric welding there is also much information, the Thomson process being very fully described. It consists briefly in completing the electrical circuit through the parts to be welded together, the resistance being sufficient to heat the parts so as to weld them, this being assisted by pressure.

The Bernado process is not described; in this process the work to be welded is connected to one terminal of the dynamo. The positive terminal being connected with a carbon rod, held in a portable insulated holder, the carbon rod is then placed on the work, and immediately withdrawn slightly, thus forming an arc, where the metal melts, and with skill much can be done.

The locomotive practice in America has long been of interest to locomotive engineers in this country, owing to the many differences in design and practice. A very good *résumé* of American practice is to be found in the memoir under this heading. A useful table is given showing a few leading dimensions, weights, &c., of typical engines in use. Take, for instance, the express passenger engine, a four-coupled bogie engine, the cylinders being 20 inches in diameter and 24 inches stroke. The driving or coupled wheels are 72 to 78 inches in diameter. The weight on coupled wheels is 75,000 pounds (33·48 tons), the total weight of the engine being 116,000 pounds (51·78 tons), and that of the tender 72,000 pounds (32·14 tons. Comparing these data, we find that the American engine is heavier than an 18×26 cylinder British engine and not so powerful, assuming equal steam pressures; the tender is light in a similar comparison, probably carrying less water. The reputed weight of trains hauled given in the table is of little use, because the speeds are not given, and for this reason comparisons cannot be made.

The paragraph on locomotive boiler construction is far too short; many interesting details might have been added. It is stated that the circular smoke-box tube plate is a conspicuous difference between the practices of the two countries, being purely American, whereas the Midland Railway Company have, amongst others, used the arrangement for some time. Owing to the enforced use of anthracite coal in certain parts, many peculiar designs of locomotive boilers have been used, the Wootten boiler being probably the most common. All, however, have particularly large grate areas, which, in the case of the Wootten, may in some cases exceed 76 square feet, or four times the area of the grate of recent British engines. An illustration is given of an engine of this type, as well as a full-page engraving of a compound locomotive with a similar boiler. This compound is very different from the Webb or Worsdell engines common in this country, being the design of the superintendent of the Baldwin Locomotive Works. The cylinders are outside the frames—there are two on each side, viz. one high-pressure and one low-pressure. The distribution of the steam being effected in each pair by one piston valve, each pair of pistons is connected to one crosshead, coupled in the usual way to the wheels.

A compound engine of the "Webb" type is also illustrated. This engine was constructed to Mr. Webb's designs in this country for the Pennsylvania Railway in 1889. It is stated that the results of experiments showed a saving of fuel over the ordinary engine of from 20 to 25 per cent.

This book is so full of interesting matter of so varied a nature that it would be possible to prolong this notice far beyond the space available. Take, for instance, agricultural machinery; the Price ploughing outfit is typical of the rest, consisting of a traction engine drawing four gangs of three ploughs, the twelve ploughs cutting eleven feet wide. The subject of milling tools is also of interest, because it is only during the last few years British engineers have used this means of shaping metals, the system having been brought into general use in the States.

Under the head of the manufacture of steel all the usual processes are described. We are informed that the Whitworth compression process is only partly successful in the formation of sound ingots; with this statement we cannot agree; the Whitworth steel ingot after compression is certainly sound throughout.

Taking into consideration the great mass of information contained in the 900 odd pages of this work, and the general excellence of the matter accumulated, it is only just to congratulate the editor on the completion of a work which must prove useful to many, and which should find a place in all technical libraries. The volume goes far to describe modern American mechanism, exhibiting the latest progress in machines, motors, and the transmission of power.

SEEDLINGS.

A Contribution to our Knowledge of Seedlings. By the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., D.C.L., LL.D., with 684 figures in text. In two volumes. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1892.)

SEEDS and seedlings have occupied the attention of Sir John Lubbock for a somewhat lengthened period. They have formed the subject of various communications, on his part, to the Journal of the Linnean Society and other publications. In the present volumes, modestly styled a "contribution," he gives us the details upon which his inferences have been founded.

The physical and chemical aspects of germination are entirely passed over, but the morphological phenomena are treated with a fulness never before attempted. The author has availed himself of the resources put at his disposal by the authorities at Kew, where the larger proportion of the seedlings described were grown expressly for the purpose. The Natural History Museum and the Cambridge Botanic Gardens have also been requisitioned, and much help has been rendered by capable assistants, whilst the services of Sir Joseph Hooker and Mr. Rendle, in looking over the proof sheets, are duly acknowledged. A work of such dimensions, crowded with detail, could hardly have been produced without such zealous co-operation. Nevertheless unity of plan and uniformity of treatment are conspicuous throughout, and thus comparison is readily effected.

Some previously published papers in the Journal of the Linnean Society, dealing with the causes which determine the form of leaves and cotyledons, are reprinted as the introduction to the treatise. The conclusion therein arrived at is that the form of the embryo, and especially that of the cotyledons, is essentially influenced by the form of the seed. On p. 78 the author begins the detailed examination of seedlings taken from almost all the orders of flowering plants. Five hundred and thirty succeeding pages in the first volume, and five hundred and eighty-eight in the second volume, are thus occupied. This little bit of statistics will serve to show the amount of detail which is contained within these volumes. The plan adopted is to give, first of all, a general sketch of the principal modifications exhibited by the fruit and seed in each order. Then follows a more detailed description of the seed and of the seedling plant in various representatives of the order. As these descriptions are identical in plan throughout, they are of great value to the student of comparative morphology. Naturally some orders are much better represented than others, but sometimes the omissions are rather unfortunate. In the genus Araucaria, for instance, seedling representatives of which are common in botanic gardens and nurseries, the diversities in the form of the seedling and in the mode of germination are very remarkable. "Characters" derived from the seedling plant have been recognized as of the highest importance for classificatory purposes since the time of John Ray (1682-1703).[1]

But whilst this is generally the case, such extraordinary exceptions as that mentioned in Araucaria are very noteworthy, and not less so because the genus in question is one of the very oldest of which fossil botanists have cognizance.

Myrtaceæ and Sapindaceæ are remarkable for the extremely diverse character of the embryo in different genera, and of which due note is taken in Sir John Lubbock's book. In Rosaceæ, on the other hand, the diversity is much less, nor is there any important morphological difference in the seedlings of the great order Compositæ, and scarcely more in Umbelliferæ, so far as they are known. These are facts of great significance with reference to the theories of inheritance and relative antiquity of groups.

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[1] It may not be without interest to cite what Ray says on this matter:—"Floriferas dividemus in *dicotyledones* quarum semina sata binis foliis anomalis, seminalibus dictis, quæ cotyledonum usum præstant, e terra exeunt vel in binos saltem lobos dividuntur, quamvis eos supra terram foliorum specie non efferant; et *monocotyledones* quæ nec folia seminalia bina efferunt nec lobos binos condunt." Thus Ray not only recognized the presence of one or of two cotyledons, but also their nature and their epi- or hypogeal condition. As Ray has been mentioned, it is certainly not inappropriate to allude to Grew also, for the first chapter of his "Anatomy of Plants" (1682), and the whole of the fourth book is devoted to the seeds and seedlings and in perusing them the reader will perceive that Sir John Lubbock has in a few cases been anticipated by his celebrated predecessor.